

Research Article

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Micronutrient level in relation to other soil properties of Koronivia, Fiji

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Summary

The aim of this study was to evaluate available micronutrient (Fe, Cu, Mn and Zn) status and their relationship with the soil properties. Twenty four soil samples were collected from various locations of Koronivia, Fiji to determine properties of soil. The available micronutrient (DTPA extractable) viz., Fe, Mn, Cu and Zn were analyzed using atomic absorption spectrophotometer. The laboratory analyzed data revealed that soils of the study area are acidic in nature with low values of organic carbon and electrical conductivity. Available micronutrients analysis revealed that iron (Fe), manganese (Mn) and copper (Cu) were found to be sufficient in most of the soil samples, whereas, available zinc (Zn) was found to be deficient in most of the analyzed samples. Further, pH showed a positive correlation with Cu and negative correlation with Mn. Organic carbon showed a positive correlation with Fe and Mn. CEC showed positive correlations with Fe, Mn and a negative correlation with Zn.

Key words : Soil properties, Available micro nutrients, Koronivia

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Introduction

Soil plays an important role in determining sustainable productivity of an agro-ecosystem. The sustainable productivity of soil mainly depends upon its ability to supply essential nutrients to the growing plants. Deficiency of micro nutrients has become major constraint to agricultural productivity, stability and sustainability of soils (Bell and Dell, 2008). The main source of these micronutrient are parent material, sewage sludge, town refuse, farm yard manure (FYM) and organic matter. These micronutrients occur in very small amount in the soil ranging from few mg kg⁻¹ to thousand mg kg⁻¹ in soil. The concept of soil health and soil quality has consistently evolved with an increase in understanding of soils and soil quality attributes. Important role of micronutrients in maintaining soil health and

enhancing crop yields is recognized all over the world. The quality of soil is controlled by physical, chemical and biological components of a soil and their interaction (Papendick and Parr, 1992). Uptake of micronutrients is affected by presence of major nutrients due to either negative or positive interactions (Fageria, 2001). Indiscriminate uses of macro nutrients may affect uptake of micro nutrients (Dadhich and Somani, 2007). Soil properties cannot be measured directly, but soil properties that are sensitive to changes in the management can be used as indicators (Andrew *et al.*, 2004). Soil pH is a good indicator of available plant nutrients (James, 2007). Due to continuous cultivation, soils under particular land use system may affect physico-chemical properties which may modify DTPA extractable micronutrients content and their availability to plants. Keeping in view the above

points the research was conducted to study the micronutrients level in relation to other soil properties of the studied area.

Resource and Research Methods

The study was conducted at the crop farm college of Agriculture, Fisheries and Forestry (CAFF), Livestock farm, Pasture land, Research farms and surrounding Farmer fields of Koronivia. The geographical reference of the study area are $18^{\circ}2'30''$ - $18^{\circ}3'36''$ S, $178^{\circ}31'17''$ - $178^{\circ}33'10''$ E and elevation ranges from 6 meter to 23 meter above mean sea level. The climate of the study area is tropical with moderate temperature (22° - 28° Celsius) having annual rainfall about 3000 mm (Fiji, 2013). Studied soils are acidic in nature with variation in pH from 5.1-6.6; low to medium organic carbon content and very low electrical conductivity (0.01 - 0.08 dSm $^{-1}$). Twenty four representative soil samples were collected from 12 sites (Fig.A) keeping in view the heterogeneity of soils emphasizing variation in soil type, slope and land use to determine soil properties and micronutrient status. Soils samples were prepared as per standard methods of sample preparation and stored in properly labeled plastic bags for analysis. The list of sampling sites with location name is given in Table A. Standard analytical methods used (Richards, 1954 and Jackson, 1973) for measuring various soils attributes like pH, EC, organic carbon and CEC. The available micronutrients Fe, Mn, Cu and Zn of soil samples were extracted with a DTPA solution (Lindsay and Norvell, 1978). The concentration of micronutrients in the extract was determined using

Table A: Sample collection location and number on the map

No. on map	Location
1.	Live stock farm
2.	Pasture land
3.	Scrub land
4.	Pasture land
5.	Swampy land
6.	Crop farm
7.	Farmers field
8.	Farmers field
9.	Research farms
10.	Research farms
11.	Crop farm
12.	Farmers field

atomic absorption spectrophotometer (AAS). The relationship between different soil properties and micronutrients content were determined using statistical software SPSS to calculate correlation co-efficient "r" (Table 3).

Research Findings and Discussion

The results of all relevant soil characteristics are summarized in Table 1. The soils of the study area are acidic in nature with a mean pH of 5.8. According to classification of soil reaction suggested by Brady (1985), 38 per cent samples were acidic and 62 per cent were slightly acidic. Low values of pH are due to acidic parent material, continuous rainfall that leaches most of bases throughout the year, decomposition of organic matter further decrease the soil pH (Miyauchi and Hayashi, 1985). The average electrical conductivity (EC) and organic carbon content of these soils was recorded as 0.04 dSm $^{-1}$ and 1.92 per cent, respectively. The low electrical conductivity may be ascribed as lower base concentration and leaching of salts from the soils.

Data on available iron in soil samples indicated that 91.7 per cent soil samples were found sufficient in DTPA-iron content and 8.3 per cent of the soil sample were deficient (Fig. 1), considering 4.5 mg kg $^{-1}$ as the critical limit (Lindsay and Norvell, 1978). The content of DTPA-Fe varied from 0.8 - 62.77 mg kg $^{-1}$ with an average value of 26.25 mg kg $^{-1}$. The DTPA available Mn in the soil samples varied from 0.64 - 98.93 mg kg $^{-1}$ with the mean value of 21.59 mg kg $^{-1}$ (Table 1). Based on the critical limit 3.5 mg kg $^{-1}$ for Mn deficiency (Sakal *et al.*, 1985). The 12.5 per cent soil samples were found to be deficient

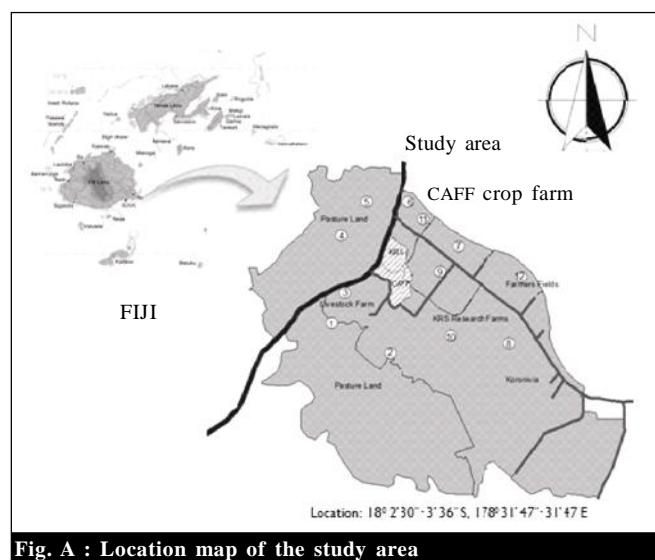


Fig. A : Location map of the study area

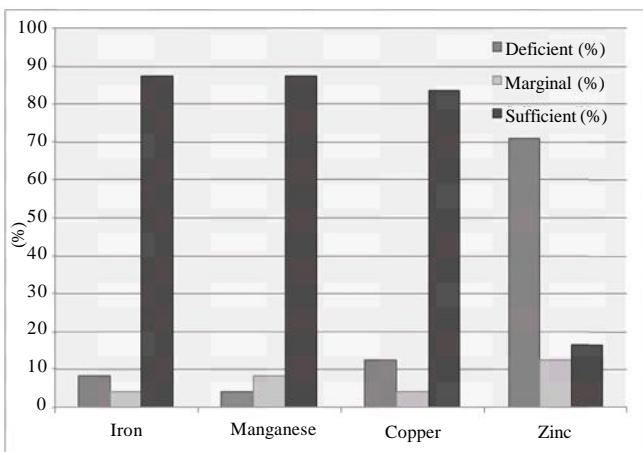


Fig. 1 : Micro nutrients stratus of soils based on their critical range

in available Mn. Available Cu content of the soil samples varied from 1.19-4.38 mg kg⁻¹ with mean value of 1.65 mg kg⁻¹ (Table 1). The data indicated that 16.7 per cent soil samples were below the critical level (Lindsay and Norvell, 1978). Available Zn in the soil samples varied from 0.01-4.83 mg kg⁻¹ with mean value of 1.03 mg kg⁻¹ (Table 1). On the basis of critical limit (0.60 mg kg⁻¹) suggested by (Takkar and Mann, 1975) 70.8 per cent

samples were deficient in DTPA extractable Zn that require Zn application for optimum production and to get full benefit of applied NPK fertilizers in the studied area, 12.5 per cent samples were marginal and 16.7 per cent of the samples were sufficient in Zn availability. All the investigated micronutrients are influenced by the soil environment (Lindsay and Norvell, 1978). Soil pH has been comprehensively identified as the single most important soil factor controlling the availability of micronutrients in soil. The average value of Fe increased significantly with an increase in organic carbon ($r=0.29$), Cu ($r=0.56$) and Zn ($r=0.67$). The Mn availability was positively correlated with EC ($r=0.31$) and CEC($r=0.35$) whereas, negative correlation was observed with pH. The Cu availability was positively correlated with pH ($r=0.56$), Zn ($r=0.59$) and CEC ($r=0.38$). The availability of Zn increased with increase in EC ($r=0.17$), whereas, decreased with CEC ($r=-0.15$) (Table 3).

Conclusion :

The study revealed that availability of iron, copper and manganese in these soils appeared to be adequate whereas, zinc availability is at deficient level. Results indicated that soil pH and organic carbon are the main

Table 1: The average range of micronutrients of soils

Sr. No.	Available micronutrients	Micronutrients content (ppm)		
		Minimun	Maximum	Average
1.	Iron	0.80	62.77	26.25
2.	Manganese	0.64	98.93	21.59
3.	Copper	0.19	4.38	1.65
4.	Zinc	0.01	4.83	1.03

Table 2: Critical soil test values of DTPA extractable micronutrients

Sr. No.	Micronutrients	Nutrients content (mg kg ⁻¹)		
		Low	Medium	High
1.	Iron (Lindsay and Norvell, 1978)	<4.50	4.5-9.0	>9.0
2.	Manganese (Sakal <i>et al.</i> , 1985)	< 2.5	2.5-3.5	>3.5
3.	Copper (Lindsay and Norvell, 1978)	<0.2	0.2-0.4	>0.4
4.	Zinc (Takkar and Mann, 1975)	<0.6	0.6-1.2	>1.2

Table 3: Correlation co-efficient values of important soil properties

Soil properties	Fe	Micronutrients		
		Mn	Cu	Zn
Soil pH	-0.05	-0.37	0.55**	-0.03
Organic carbon	0.29	0.13	0.32	0.08
Electrical conductivity	0.17	0.31	0.40	0.17
Cation exchange capacity	0.10	0.35	0.39	-0.15

** indicate significance of value at P=0.01

soil characteristics which control the availability of these micronutrients.

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